# Integrating Economics and Biology in the Assessment of Risk of Invasive Species

Economics of Invasive Species
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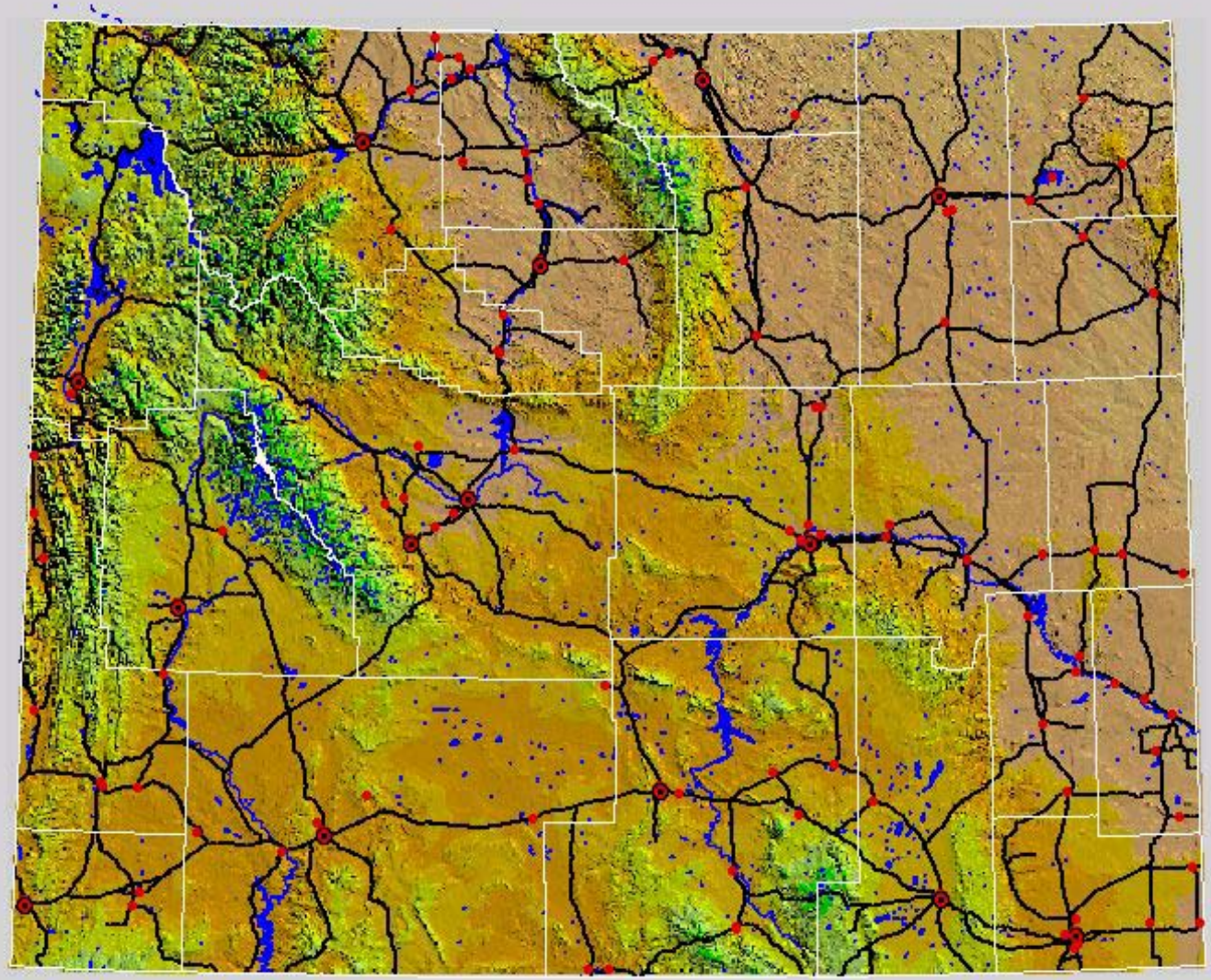
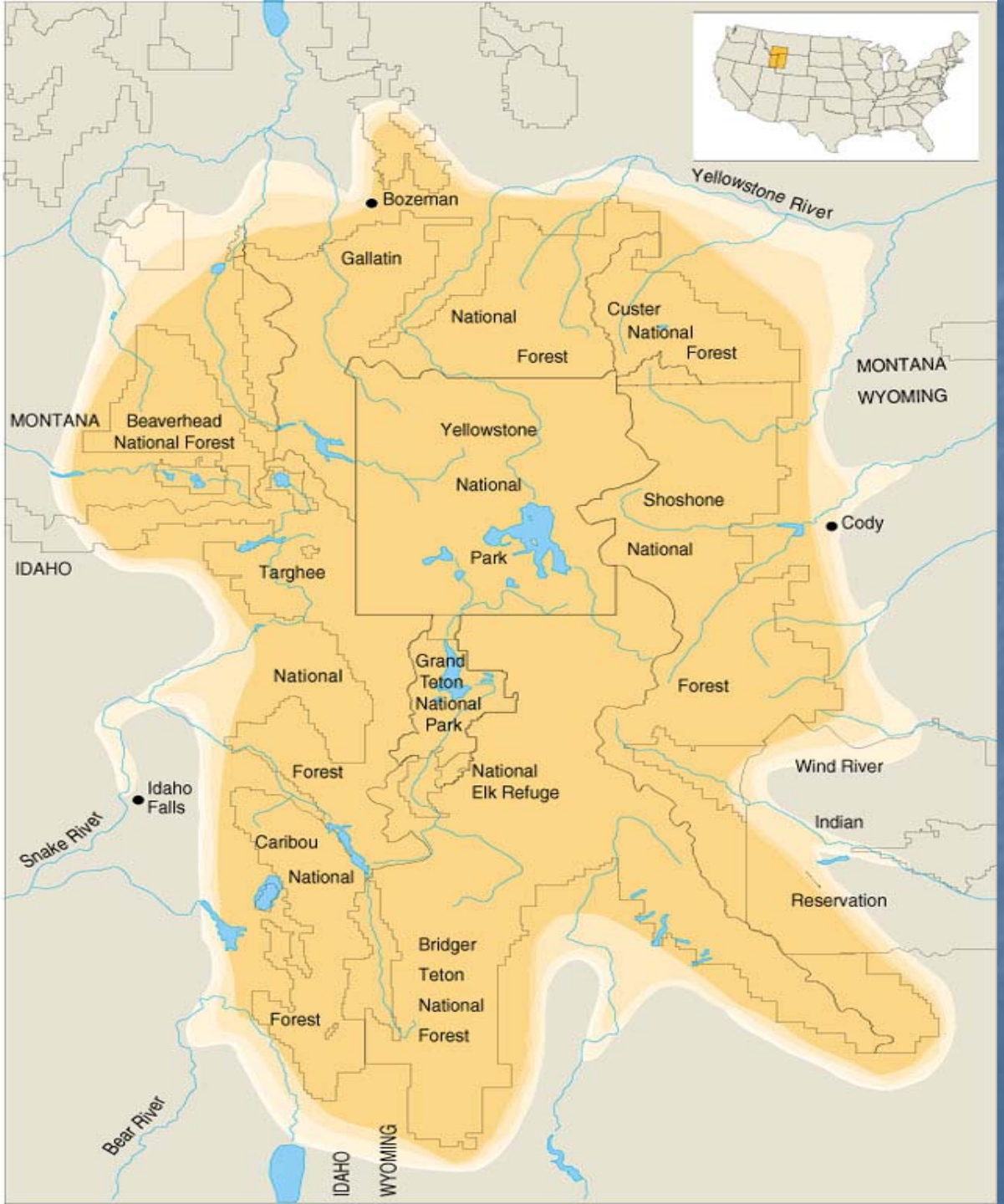
# View toward modeling

- Risks to people and nature are endogenous
- Human and natural systems are intertwined
- Combine the economic approach of constrained optimization with biological constraints
- Humans maximize total benefits of the ecosystem, including ecological products, given budget limitations and biological constraints of the ecosystem

# Two Examples of Bioeconomic Risk Assessment

- Cutthroat trout vs. Lake trout in Yellowstone Lake
- Zebra mussels in the Great Lakes




Yellowstone River
Bozeman
Gallatin
National
Forest
Custer
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MONTANA
WYOMING
MONTANA
Beaverhead
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Yellowstone
National
Park
Shoshone
National
Forest
Cody
IDAHO
Targhee
National
Forest
Grand
Teton
National
Park
National
Elk Refuge
Wind River
Indian
Reservation
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Snake River
Caribou
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Bridger
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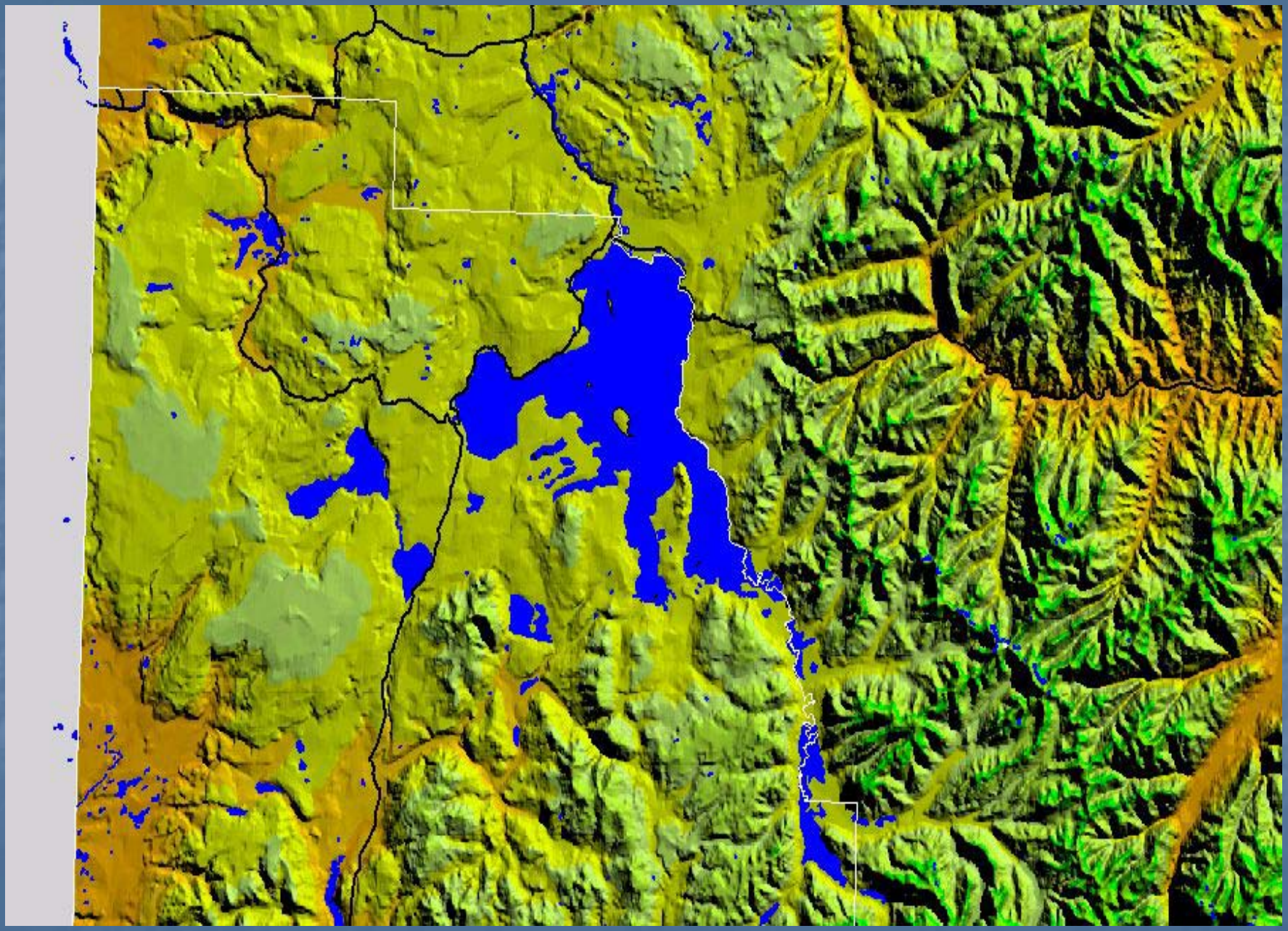
Bear River
IDAHO
WYOMING



# Yellowstone Lake example: Optimal Control Approach and STELLA Modeling

- The ecosystem model is a predator-prey model between lake trout and cutthroat trout, in which other species like grizzly bears and eagles also prey on cutthroat trout.
- Humans impact the ecosystem by reducing the population of cutthroat trout, which affects predators.
- National Park Service managers determine how to allocate the park's limited budget and how to manage the visitors to the park.

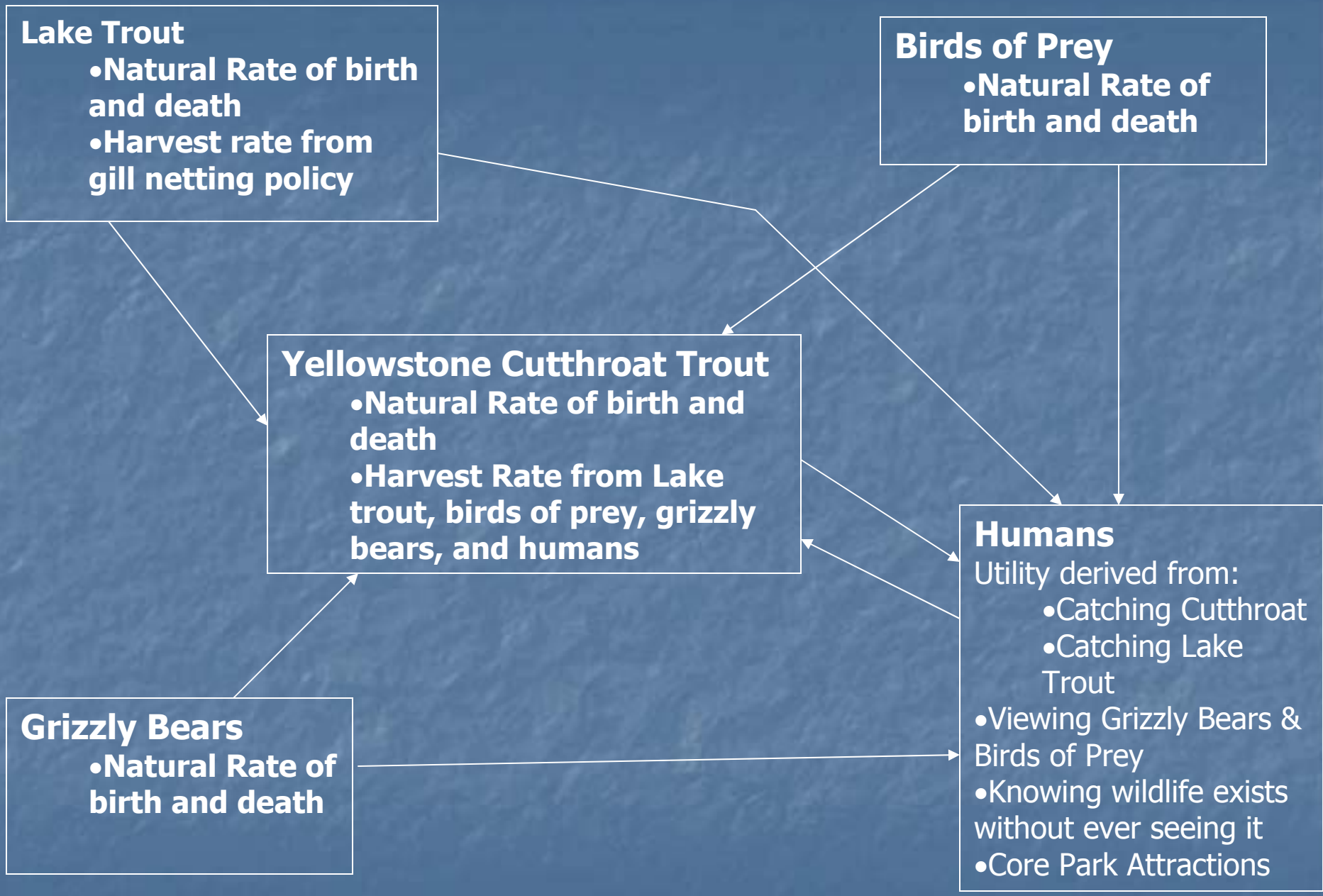



Figure 1. Diagram of Integrated Model of Yellowstone Lake

# Does integration matter for risk assessment?

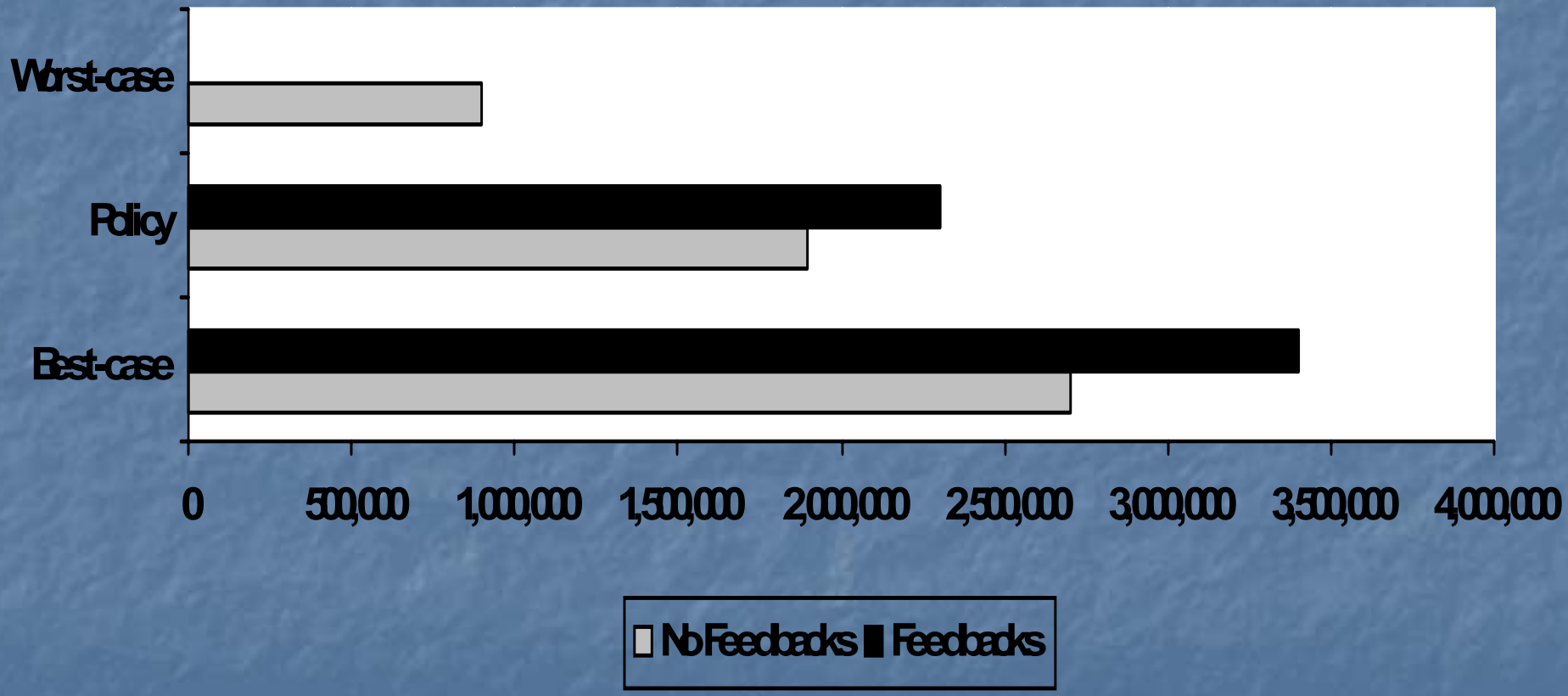
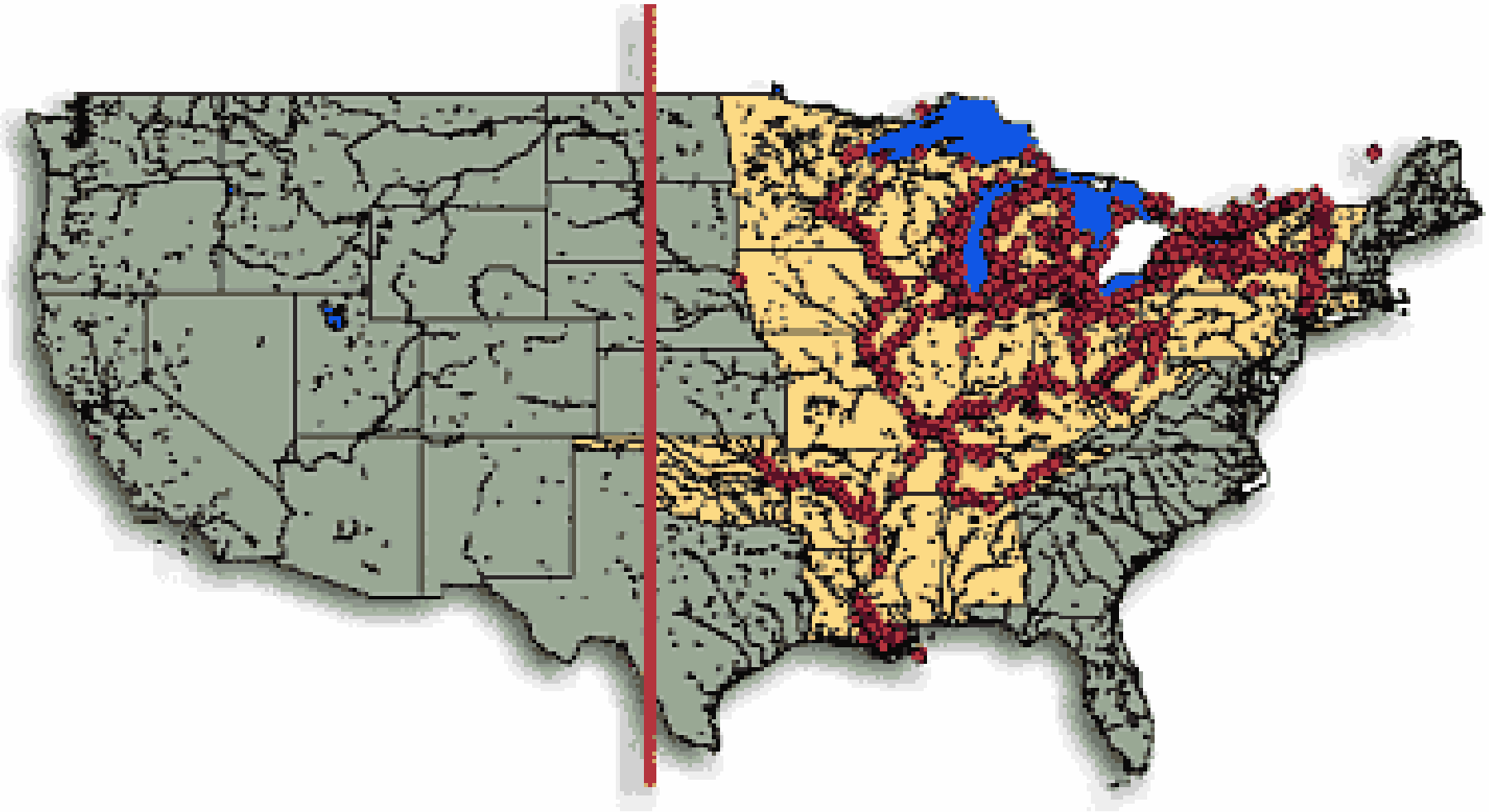



**Table 1: Steady state population of cutthroat trout across scenarios**
**From Settle and Shogren, 2002, *AJAE***

# Does integration matter for policy?

- Forget the fish, fix the roads
- Visitor preferences lean heavily toward viewing the core attractions not saving cutthroat trout

# 2000 Zebra Mussel Distribution



● = confirmed zebra mussel sightings from 1988 to 2000

# Zebra Mussels: Stochastic Dynamic Programming

- **Society would derive a net benefit of $_____ from investing up to $_____ in Prevention versus $_____ Control?**

# Central questions for a bioeconomic evaluation

1) Which are good habitats for zebra mussels?

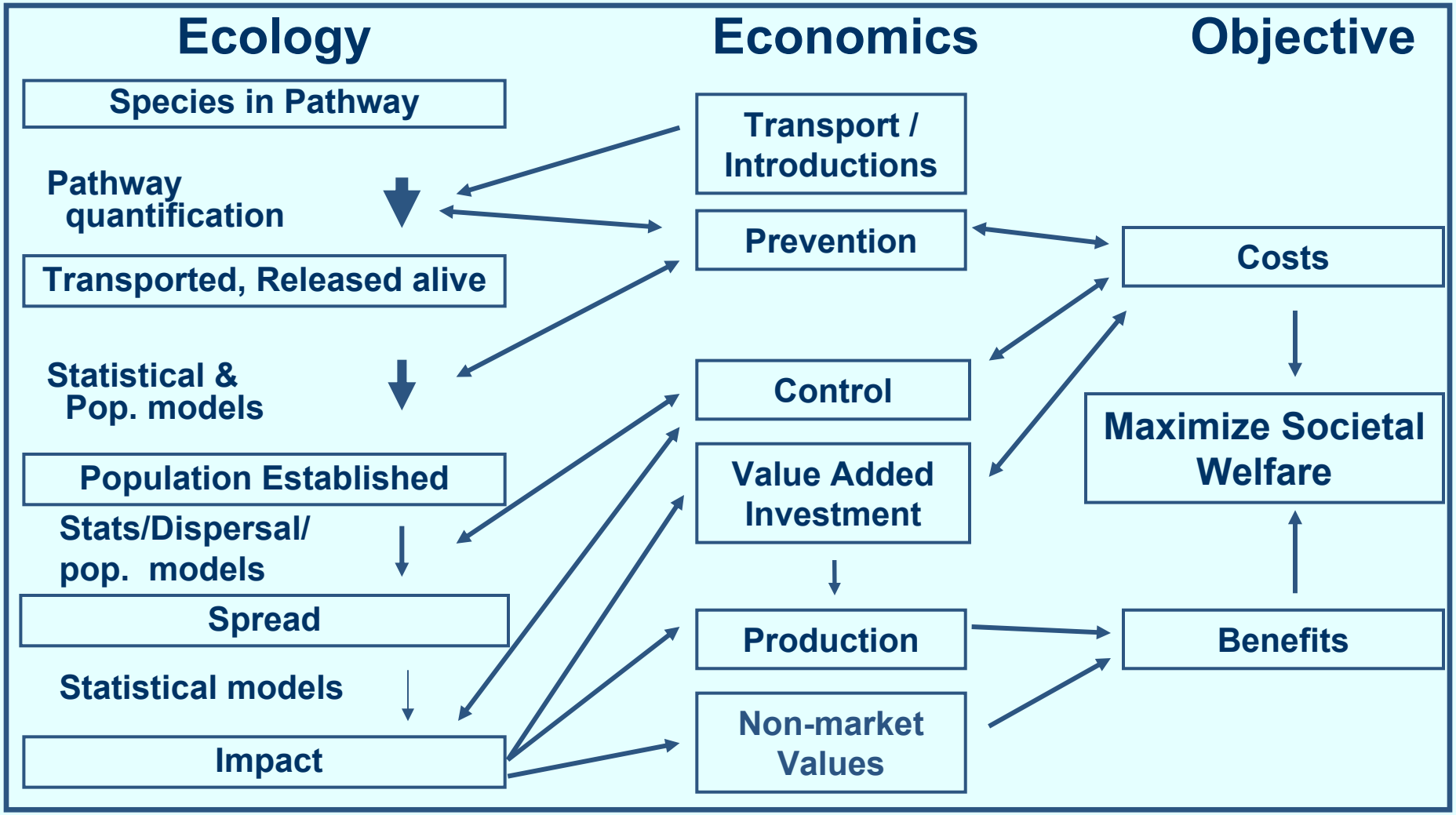
2) Pathways for zebra mussels to new habitats?

3) At-risk commercial & environmental goods & services? Market costs if zebra mussels become abundant?

4) Costs & effectiveness of prevention strategies?

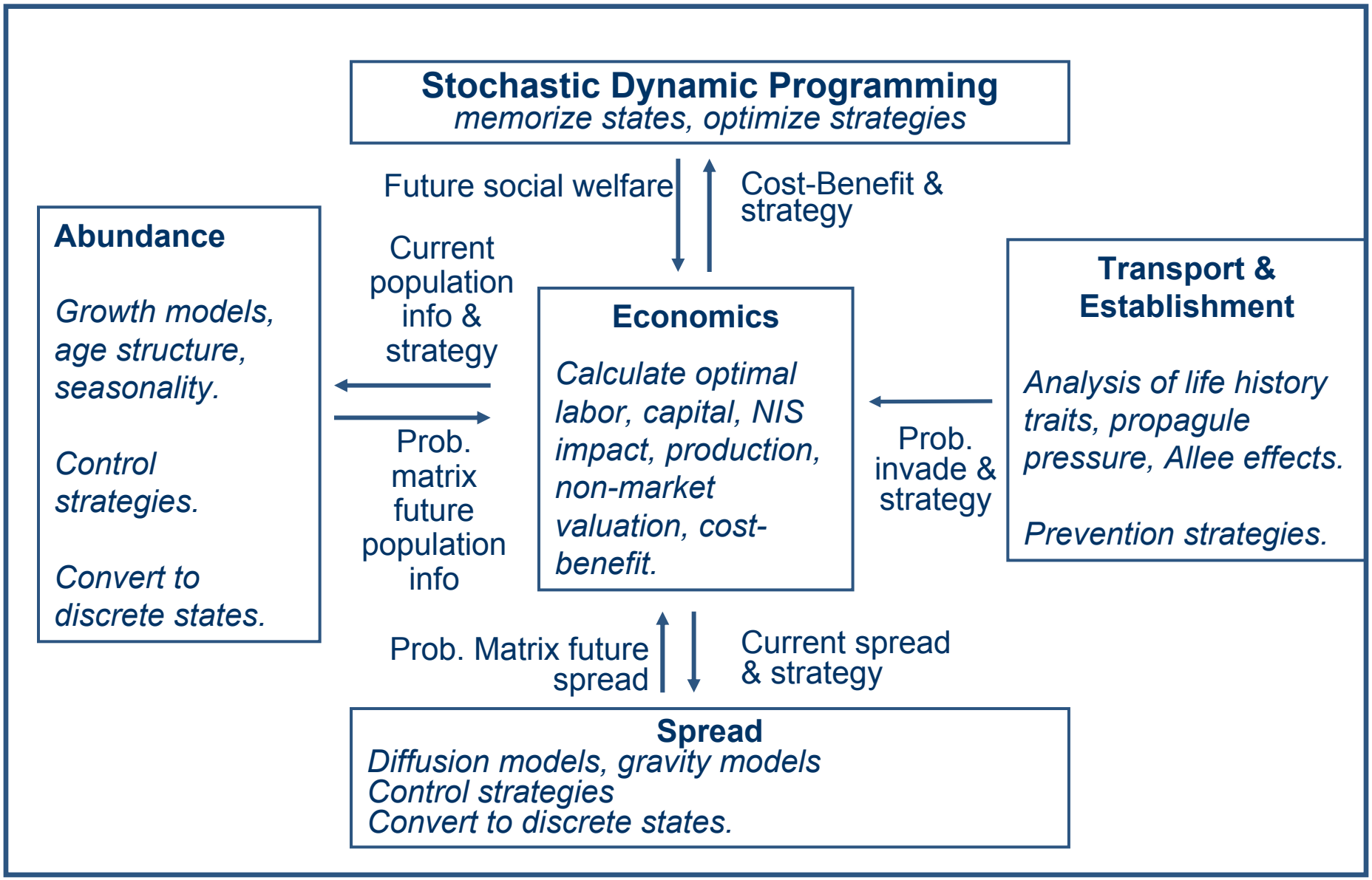
5) What would be the most cost-effective level of investment in prevention and control?

# Conceptual Approach




(From Leung et al. 2002, *Proc. Biological Sciences*)

# Model Structure: **Modules**, *functions*, interfaces



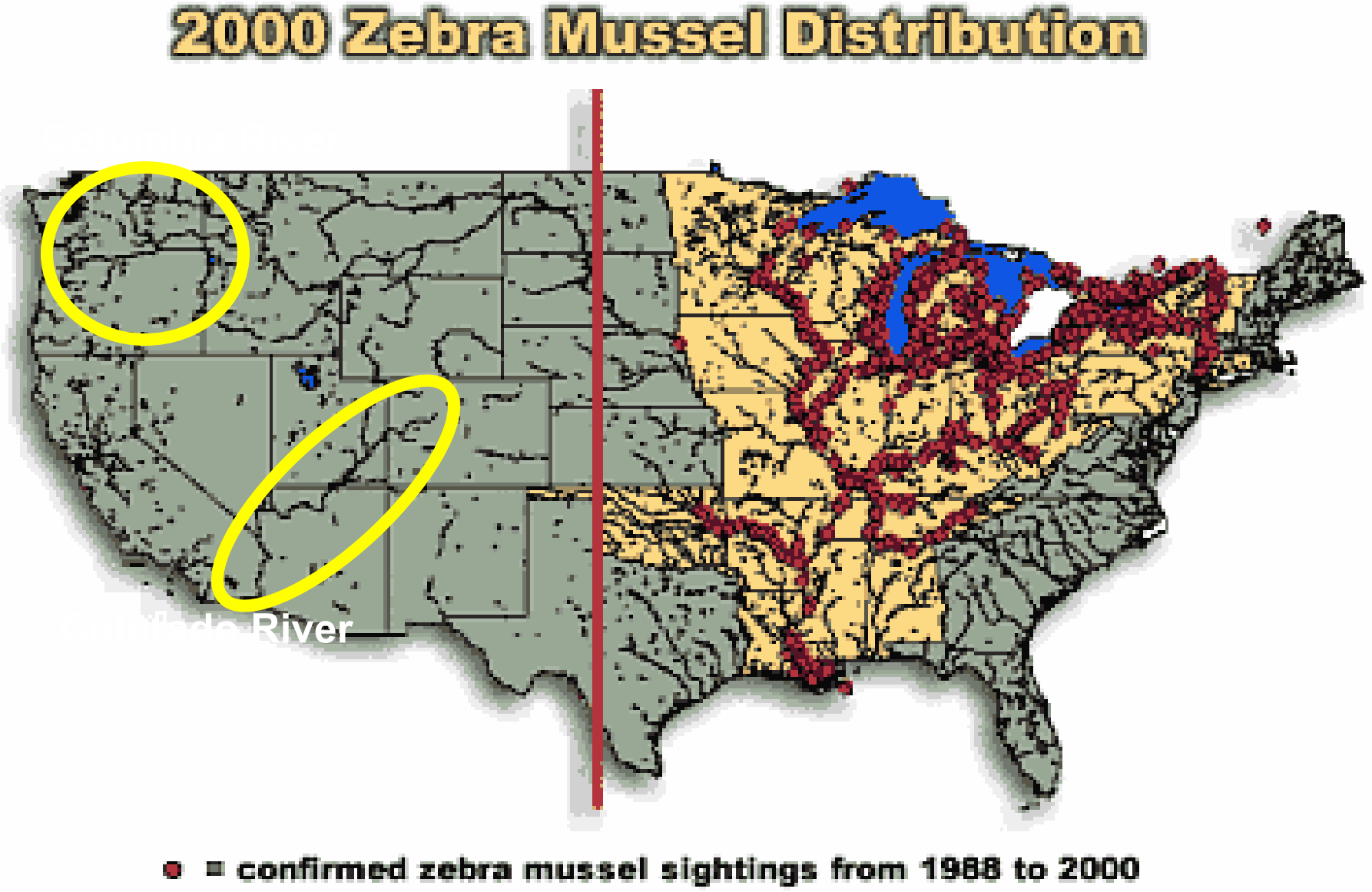
# The Value of Prevention: What's it worth to keep zebra mussels out of the next lake?

**Up to $324,000 per year *per lake* to prevent invasion —to protect power plants alone.**

**For comparison, in FY2001, the USFWS distributed to the States $825,000 in response to *all aquatic invasive species in all lakes in all states*.**

(From Leung et al. 2002, *Proc. Biological Sciences*)

# 100th Meridian Initiative



# Other approaches

- Bioeconomic General Equilibrium models [John Tschirhart and David Finnoff]
- Bioeconomic Stopping problems and Real options theory [Jean-Daniel Saphores]

# What matters in Integration

- Feedback loops
- Opportunity costs
- Biological thresholds
- Self-protection (prevention/mitigation)
- Self-insurance (control/adaptation)
- Preferences